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Original Research Article

A COMPARATIVE STUDY OF EFFICACY ON 0.5% BUPIVACAINE VS 0.5% ROPIVACAINE IN USING USG GUIDED SUPRACLAVICULAR BLOCK FOR UPPER LIMB SURGERY

Ruban I[1], R. Girish Soundhar[2], Sowmiya I[3], K. Rekha[4], Sathya Mohan[5], M. Reshma[6]

[1]MSc Anaesthesia Technology- 2nd Year Student, School of Allied health sciences, Dhanalakshmi Srinivasan University, Trichy, Tamil Nadu, India
[2]Assistant Professor, Department of Anaesthesia, Srinivasan Medical College & Hospital, Samayapuram, Trichy, Tamil Nadu, India
[3]Assistant Professor, Department of Anaesthesia, Srinivasan Medical College & Hospital, Dhanalakshmi Srinivasan University, Trichy, Tamil Nadu, India.
[4(1)]Professor & Head, Department of Physiology, Srinivasan Medical College & Hospital, Dhanalakshmi Srinivasan University, Trichy, Tamil Nadu, India.
[4(2)] Dean, SAHS. DSU, Trichy
[5]Associate Professor, Department of Biochemistry School of Allied health Sciences, Dhanalakshmi Srinivasan University, Trichy
[6]Msc Anaesthesia Technology, Srinivasan Medical College & Hospital, Dhanalakshmi Srinivasan University, Trichy, Tamil Nadu, India.

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Corresponding Author:
Ruban. I
Email: rubanilango2000@gamil.com

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ABSTRACT

Background: Regional anaesthesia using brachial plexus block is widely preferred for upper limb surgeries, with ultrasound guidance improving accuracy and safety. Among local anaesthetic agents, bupivacaine and ropivacaine are commonly used, but comparative evidence regarding their efficacy and safety remains inconsistent. **Materials and Methods:** This prospective comparative study was conducted on 120 patients undergoing elective upper limb surgeries. Patients were randomized into two groups of 60 each: Group A received 0.5% bupivacaine (20 mL), and Group B received 0.5% ropivacaine (20 mL) via ultrasound-guided supraclavicular brachial plexus block. Parameters evaluated included onset and duration of sensory block, onset and duration of motor block, duration of analgesia, and intraoperative haemodynamic stability. Statistical analysis was performed using SPSS version 23, with $p < 0.05$ considered significant. **Result:** The onset of sensory block was significantly faster in the ropivacaine group compared to the bupivacaine group ($p < 0.05$). The onset of motor block also showed earlier initiation with ropivacaine. However, the duration of both sensory and motor block was longer in the bupivacaine group ($p < 0.05$). Analgesia duration was extended in patients receiving bupivacaine, while ropivacaine offered the advantage of quicker block onset and satisfactory intraoperative stability. No major complications were reported in either group. **Conclusion:** Both 0.5% bupivacaine and 0.5% ropivacaine are effective agents for ultrasound-guided supraclavicular brachial plexus block in upper limb surgeries. While ropivacaine provides earlier onset of sensory and motor blockade, bupivacaine offers prolonged duration of anaesthesia and postoperative analgesia. The choice of agent should therefore be individualized based on surgical requirements and anticipated postoperative pain management needs.

INTRODUCTION

Regional anaesthesia has become central to upper-limb surgery because it provides high-quality surgical anaesthesia with prolonged postoperative analgesia, decreases perioperative opioid exposure, facilitates day-care pathways, and allows targeted physiological monitoring compared with general anaesthesia. Within peripheral nerve blocks, the supraclavicular approach to the brachial plexus offers dense, reliable anaesthesia for procedures on the forearm, wrist, and hand by addressing the trunks/divisions of the plexus in a compact anatomical space.[1] Historically, concerns with landmark or nerve-stimulator techniques included variable success, vascular puncture, and rarely

pneumothorax. The adoption of ultrasound guidance has markedly improved visualisation of neural structures and adjacent vessels, enabled real-time needle control, reduced local-anaesthetic volumes, and increased block success and safety, making ultrasound-guided supraclavicular block a preferred technique in many centres.[2]

Choice of local anaesthetic dictates not only intraoperative conditions but also recovery kinetics and safety. Bupivacaine (amide class) is valued for its potency and long duration, producing profound sensory and motor blockade suitable for prolonged procedures and extended analgesia. Its recognised drawback is a higher risk of cardiotoxicity in cases of inadvertent intravascular injection or overdose, which mandates meticulous technique and monitoring.[3] Ropivacaine, the pure S-enantiomer related to bupivacaine, was developed to provide a safer profile with relatively less cardiotoxic and central nervous system toxicity. Clinically, it often exhibits a slightly shorter duration of action and a degree of sensory-motor differentiation that can favour earlier motor recovery useful for ambulatory surgery, early physiotherapy, or when motor function monitoring is desirable.[4]

Comparative studies have reported heterogeneous findings because of variations in concentration (0.5% vs 0.75%), total volume administered, adjuvants (e.g., dexmedetomidine, clonidine, epinephrine), block approach, and outcome definitions. Some investigations suggest earlier onset with ropivacaine, while others show longer sensory and motor duration with bupivacaine.[5] Haemodynamic stability is a practical consideration: both drugs are generally well tolerated in ultrasound-guided practice, yet ropivacaine is often preferred when cardiovascular safety margins are prioritised. Taken together, the literature indicates that drug selection should be individualised to surgical duration, postoperative analgesia requirements, and patient comorbidities; however, there remains value in head-to-head evaluations using equal concentrations and standardised ultrasound technique to clarify trade-offs relevant to routine clinical practice.[6]

The present thesis from Dhanalakshmi Srinivasan University focuses precisely on this clinical decision point, comparing 0.5% bupivacaine with 0.5% ropivacaine for ultrasound-guided supraclavicular block in adults undergoing upper-limb surgery.[7] Outcomes reported include onset times for sensory and motor block, duration of analgesia and motor blockade, perioperative heart rate and blood pressure trends across defined time intervals, rescue-analgesic requirements, and adverse events. The study's design employs prospective enrolment, random allocation, and blinded assessment, with standard monitoring and block performance under real-time ultrasound visualisation features that enhance internal validity and clinical applicability.[8]

Pragmatically, if bupivacaine yields longer analgesia and motor block, it may be advantageous for lengthy reconstructions or where prolonged postoperative pain is anticipated. Conversely, if ropivacaine demonstrates faster onset with comparable surgical conditions and steadier haemodynamics, it may be preferred for ambulatory pathways or patients in whom cardiovascular safety and earlier motor recovery are priorities.[9,10]

Therefore, it is of interest to compare, at equal 0.5% concentration under ultrasound guidance, the efficacy (onset and duration of sensory and motor blockade, analgesia) and safety (haemodynamic stability and adverse effects) of bupivacaine versus ropivacaine in supraclavicular brachial plexus block for upper-limb surgery, to inform evidence-based agent selection in everyday practice.

Aim and Objectives

Aim

The study aimed to compare the efficacy of 0.5% bupivacaine and 0.5% ropivacaine administered via ultrasound-guided supraclavicular brachial plexus block in patients undergoing upper limb surgeries.

Objectives

Primary objectives

- To evaluate and compare the duration of analgesia between the two groups.
- To assess and compare the duration of motor blockade.

Secondary objectives

- To monitor the effect of each drug on haemodynamic parameters.
- To identify and record any adverse effects associated with either agent

MATERIALS AND METHODS

This prospective, randomized, double-blind comparative study was conducted at Dhanalakshmi Srinivasan University, Samayapuram, Trichy, after obtaining institutional ethical clearance and informed consent from all participants. The study duration was twelve months.

Study Design and Population

A total of 120 patients aged 18–50 years, classified as ASA I or II, and scheduled for upper limb surgeries under regional anaesthesia were enrolled. Participants were randomly allocated into two equal groups of 60 patients each using a computer-generated randomization table.

- Group A: received 20–30 ml of 0.5% bupivacaine.
- Group B: received 20–30 ml of 0.5% ropivacaine.

Drug volume was adjusted to individual patient weight. Both patients and outcome assessors were blinded to group allocation.

Inclusion Criteria

- Age above 18 and up to 50 years.
- ASA physical status I and II.
- Patients undergoing upper limb surgery.
- Written informed consent provided.

Exclusion Criteria

- Patients' refusal.
- ASA III and IV.

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- Cardiac, pulmonary, hepatic, or renal disorders.
- Head injury.
- Physical dependence on narcotics.
- Peripheral neuropathy.
- Known allergy to local anaesthetics.

Preoperative Preparation and Monitoring

All patients were kept nil per oral for 6–8 hours before surgery in accordance with fasting guidelines. On arrival in the operating room, baseline vital parameters—heart rate, blood pressure, respiratory rate, and oxygen saturation (SpO_2)—were recorded. Standard ASA monitoring (ECG, non-invasive blood pressure, and pulse oximetry) was instituted. Intravenous access was secured, and resuscitation equipment with emergency drugs was kept available.

Technique: The supraclavicular brachial plexus block was performed under strict aseptic precautions using a high-frequency linear ultrasound probe. The allocated anaesthetic solution was injected in incremental aliquots under real-time ultrasound guidance, ensuring perineural spread. Negative aspiration was performed before each injection to prevent inadvertent intravascular administration.

Outcomes Measured

- Primary outcomes: onset of sensory block (assessed by loss of pinprick sensation in brachial plexus dermatomes) and onset of motor block (assessed by loss of motor function in the upper limb).
- Secondary outcomes: duration of sensory block, duration of motor block, total duration of analgesia (time from block completion to first request for rescue analgesia), intraoperative haemodynamic stability, and incidence of adverse effects such as local anaesthetic systemic toxicity (LAST), pneumothorax, vascular puncture, hematoma, Horner's syndrome, and postoperative nausea or vomiting.

Follow-Up: Haemodynamic parameters were monitored at baseline, during block administration, every five minutes for the first thirty minutes, and hourly thereafter up to twelve hours postoperatively.

Statistical Analysis: All data were entered into SPSS software for processing. Continuous variables, such as onset and duration of sensory and motor block, and duration of analgesia, were expressed as mean ± standard deviation. These were compared between groups using the Student's t-test. Categorical variables, such as demographic characteristics and incidence of adverse events, were expressed as frequencies and percentages, and analysed with the Chi-square test. A p-value of less than 0.05 was considered statistically significant for all comparisons.

RESULTS

A total of 120 patients were studied, with 60 allocated to the bupivacaine group (Group A) and 60 to the ropivacaine group (Group B). The age distribution revealed that the majority of participants were younger than 35 years, while those above 45 years formed a smaller subset. Gender distribution was nearly equal between the two groups, with a slight male predominance overall. Baseline demographic characteristics were comparable, confirming effective randomization.

Haemodynamic parameters, including heart rate, systolic blood pressure, diastolic blood pressure, and oxygen saturation, were monitored at regular intervals. Both groups demonstrated stable haemodynamics throughout surgery, with no clinically significant deviations. Heart rate and blood pressure changes followed expected perioperative trends without major differences between the two groups.

Block characteristics differed significantly between the agents. Ropivacaine demonstrated faster onset of sensory and motor block, whereas bupivacaine provided longer duration of both blocks and extended analgesia. This translated into fewer rescue analgesic requirements in the bupivacaine group. No major complications such as local anaesthetic systemic toxicity, pneumothorax, or vascular puncture were reported in either group, confirming the safety of ultrasound-guided supraclavicular brachial plexus block.

Overall, both bupivacaine and ropivacaine were effective agents, with differences primarily related to onset and duration of block. Ropivacaine offered rapid onset and stable intraoperative conditions, while bupivacaine provided prolonged block duration and extended postoperative analgesia.

Table 1: Age distribution of study participants

Age Group (years)	Group A: Bupivacaine (n=60)	Group B: Ropivacaine (n=60)	Total (N=120)
18–25	20 (33.3%)	18 (30.0%)	38 (31.7%)
26–35	22 (36.7%)	24 (40.0%)	46 (38.3%)
36–45	12 (20.0%)	14 (23.3%)	26 (21.7%)
46–50	6 (10.0%)	4 (6.7%)	10 (8.3%)
Total	60 (100%)	60 (100%)	120 (100%)

[Table 1] shows the age distribution of participants in both groups, categorized into four age ranges.

[Table 1] Summary: The majority of participants were aged 26–35 years (38.3%), followed by 18–25 years (31.7%). Only 8.3% were above 45 years. The age distribution was balanced between the groups.

Table 2: Gender distribution of study participants

Gender	Group A: Bupivacaine (n=60)	Group B: Ropivacaine (n=60)	Total (N=120)
Male	36 (60.0%)	34 (56.7%)	70 (58.3%)

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Female	24 (40.0%)	26 (43.3%)	50 (41.7%)
Total	60 (100%)	60 (100%)	120 (100%)

[Table 2] presents the distribution of participants by gender in both groups.

[Table 2] Summary: Of 120 patients, 70 (58.3%) were male and 50 (41.7%) were female. Gender distribution was nearly equal between groups, with no significant difference.

Table 3: Comparison of heart rate changes in different time intervals

Time Interval	Group A: Bupivacaine (Mean ± SD)	Group B: Ropivacaine (Mean ± SD)	p-value
Baseline	84.12 ± 5.2	83.76 ± 4.8	0.64
5 minutes	83.22 ± 5.6	83.14 ± 5.1	0.71
10 minutes	82.64 ± 5.4	82.32 ± 5.2	0.59
15 minutes	82.18 ± 5.1	81.94 ± 4.9	0.68
30 minutes	81.92 ± 4.8	81.66 ± 4.7	0.74
60 minutes	81.54 ± 4.7	81.32 ± 4.5	0.69

[Table 3] compares mean heart rate values recorded at specific intraoperative intervals between the two groups.

[Table 3] Summary: Heart rates remained stable across both groups at all time intervals, with no statistically significant differences observed.

Table 4: Comparison of systolic blood pressure changes in different time intervals

Time Interval	Group A: Bupivacaine (Mean ± SD)	Group B: Ropivacaine (Mean ± SD)	p-value
Baseline	126.8 ± 7.2	127.2 ± 7.0	0.71
5 minutes	125.6 ± 6.9	125.8 ± 6.8	0.82
10 minutes	125.2 ± 6.8	125.4 ± 6.6	0.76
15 minutes	124.8 ± 6.5	125.0 ± 6.4	0.80
30 minutes	124.4 ± 6.2	124.6 ± 6.1	0.79
60 minutes	124.0 ± 6.1	124.2 ± 6.0	0.77

[Table 4] shows systolic blood pressure (SBP) readings at multiple intraoperative intervals in the two groups.

[Table 4] Summary: Systolic blood pressure trends were comparable between the groups throughout the surgery. No significant differences were noted.

Table 5: Comparison of diastolic blood pressure changes in different time intervals

Time Interval	Group A: Bupivacaine (Mean ± SD)	Group B: Ropivacaine (Mean ± SD)	p-value
Baseline	80.4 ± 5.1	80.6 ± 5.0	0.73
5 minutes	79.8 ± 5.0	80.0 ± 4.9	0.70
10 minutes	79.4 ± 4.8	79.6 ± 4.7	0.68
15 minutes	79.2 ± 4.7	79.4 ± 4.6	0.71
30 minutes	79.0 ± 4.5	79.2 ± 4.4	0.69
60 minutes	78.8 ± 4.3	79.0 ± 4.2	0.67

[Table 5] reports mean diastolic blood pressure (DBP) at defined intervals in both groups.

[Table 5] Summary: Diastolic blood pressure remained stable in both groups, without significant intergroup differences at any interval.

Table 6: Comparison of oxygen saturation changes in different time intervals

Time Interval	Group A: Bupivacaine (Mean ± SD)	Group B: Ropivacaine (Mean ± SD)	p-value
Baseline	98.6 ± 0.8	98.8 ± 0.7	0.41
5 minutes	98.8 ± 0.7	98.9 ± 0.6	0.46
10 minutes	98.9 ± 0.6	98.9 ± 0.6	0.91
15 minutes	99.0 ± 0.5	99.0 ± 0.5	0.84
30 minutes	99.0 ± 0.5	99.0 ± 0.5	0.97
60 minutes	99.0 ± 0.5	99.0 ± 0.5	0.94

[Table 6] presents mean oxygen saturation (SpO_2) values during the perioperative period.

[Table 6] Summary: Oxygen saturation remained consistently stable in both groups throughout the study, with no significant differences observed.

Table 7: Comparison of block characteristics and analgesia duration

Parameter	Group A: Bupivacaine (Mean ± SD)	Group B: Ropivacaine (Mean ± SD)	p-value
Onset of sensory block (min)	10.6 ± 1.2	8.2 ± 1.0	<0.05*
Onset of motor block (min)	12.4 ± 1.3	9.4 ± 1.1	<0.05*
Duration of sensory block (min)	420.6 ± 35.4	360.8 ± 32.6	<0.05*
Duration of motor block (min)	390.2 ± 30.5	340.6 ± 28.4	<0.05*
Duration of analgesia (min)	430.2 ± 40.5	370.8 ± 36.6	<0.05*
Rescue analgesic required (N)	8	15	<0.05*

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(*Significant at $p < 0.05$)

[Table 7] compares key block parameters and analgesic outcomes between the two groups.

[Table 7] Summary: Ropivacaine produced a faster onset of both sensory and motor block, while bupivacaine resulted in significantly longer duration of sensory block, motor block, and postoperative analgesia. Rescue analgesic use was lower in the bupivacaine group.

The data shows both bupivacaine and ropivacaine to be effective general anaesthesia and provided adequate control of haemodynamics, during the upper limb collection of breast cancer surgical procedures. In addition, groups were balanced for age and sex ratio to remain comparable for subsequent analysis. Heart rate, blood pressure, and oxygen saturations remained stable to confirm the safety and soundness of an ultrasound-guided supraclavicular block using either medication. Most differences were related to the characteristics of the blocks. Ropivacaine provided faster onset of sensory and motor block, lending itself towards programs requiring a faster onset of general anaesthesia. Bupivacaine provided longer duration of motor and sensory block, as well as lengthened postoperative analgesia to lessen the need for rescue medication. Aforementioned findings demonstrated no major complications from either medication. Overall, findings demonstrate a trade-off between rapid onset of ropivacaine versus prolonged analgesia of bupivacaine. Both medications demonstrated equivalent safety profiles. Therefore, choice of medication will depend on the surgical setting and postoperative analgesic needs.

DISCUSSION

Regional anaesthesia is now an important aspect of upper limb surgery due to its capability to provide dense surgical anaesthesia, decrease opioid consumption, and provide residual analgesia postoperatively. The supraclavicular approach achieves rapid and complete blockade of the upper limb below the shoulder. With development of ultrasound guidance, both success and complications (e.g. vascular puncture and pneumothorax) have improved such that the complication rate of supraclavicular block has become comparable to that of more clearly effective blocks such as the interscalene.[2,3] In this study, we evaluated 0.5% bupivacaine versus 0.5% ropivacaine, treated via ultrasound-guided supraclavicular block. Ropivacaine achieved faster onset to sensory and motor block, while bupivacaine resulted in a significantly prolonged block and analgesia postoperatively. This is consistent with prior comparative studies that have shown ropivacaine has superior onset times in comparison to bupivacaine but that bupivacaine provides a prolonged block.[4–7] Haemodynamic stability was maintained across both groups, with no significant differences in heart rate, blood pressure, or oxygen saturation at measured time intervals. This is in concert with previous studies that have shown stable haemodynamics with either drug when using ultrasound as a guide.[8,9] Ropivacaine is generally considered relatively safe from cardiotoxic effects due to its potential for greater cardiotoxicity in toxic doses; however, no cardiovascular adverse effects were observed in either treatment group in this study, which adds to the evidence that the total doses were not toxic.

The decreased requirement for rescue analgesics in the bupivacaine group illustrates an advantage of bupivacaine for prolonged postoperative comfort. Moreover, studies have shown that sensory block duration with bupivacaine is extended with a similar reduction in supplemental analgesia.[11,12] Although ropivacaine required earlier postoperative analgesia because of its duration, it may be favourable in the context of outpatient care, where faster motor recovery is preferred.[13] The clinical trade-off between the two agents is also clear. Ropivacaine provides a rapid onset advantage that can be useful in urgent or brief surgery, while bupivacaine provides a prolonged block and analgesia advantage, which is especially helpful in longer surgeries or when managing postoperative pain is important.[14-16] There are limitations to the study, although it is strength is that it was randomized, double-blinded, used ultrasound guidance and standardised as much as possible, adding to the validity and reproducibility of the findings. Other strengths involved continuous monitoring of haemodynamic variables and systematic analysis of the characteristics of the blocks, both of which add strength to the study. Nevertheless, limitations should be noted. The study population was limited to ASA I–II patients aged 18–50 years-old, limiting the applicability to elderly patients with higher comorbidity. Further, adjuvants such as dexmedetomidine or clonidine, which are used in practice to extend the duration of block, were not investigated. Finally, rare adverse events may not have been represented or may not have been noticed during the short follow up time; for patients who experience adverse events, knowing about these may be as or more important than the primary outcome of pain management.

Clinically, the selection of agent should be based on the needs of the procedure. When the duration of the procedure is longer, or extended postoperative analgesia is expected, bupivacaine is the better choice. When the procedure is shorter or under circumstances where rapid mobilization is the goal, ropivacaine has advantages clinically. Future studies should investigate outcomes in geriatric patients, study adjuvants to achieve prolonged duration, and investigate cost effectiveness in practice in different contexts. In conclusion, both bupivacaine and ropivacaine serve the purpose of ultrasound guided supraclavicular brachial plexus block. Ropivacaine achieved faster onset, and bupivacaine produced a

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longer block and longer duration of analgesia. Both medications were well tolerated with stable hemodynamics and no significant non-expected complications, indicating that either medication can be chosen regardless of the patient's clinical presentation.

Limitations

This study has several limitations that need to be taken into account. The first limitation is related to the study population, which was limited to ASA I and II patient populations between the ages of 18 and 50, which limits the external validity of the findings in this study for patients who are elderly or have significant comorbid conditions. The second limitation is that the study did not assess the use of adjuvants that are commonly used as adjuvants (e.g., clonidine, dexmedetomidine), which prolong the duration of blocks, and potentially influence the comparative data between bupivacaine and ropivacaine. The third limitation is that although the sample size of the study was sufficient to adequately balance patient demographics in the primary outcomes, in addition the size of the study was adequate for the primary outcomes, the sample size may have not been powered to detect rare complications (i.e., local anaesthetic systemic toxicity, neurological sequelae). Finally, follow-up was limited to the immediate postoperative period and neither safety or functional recovery endpoints were collected in the long term.

CONCLUSION

In this study we conclude that bupivacaine demonstrated a faster onset of both sensory and motor blockade, indicating better efficacy for intraoperative conditions. However, ropivacaine provided slightly prolonged postoperative analgesia and motor blockade. Overall, bupivacaine was found to be more efficacious due to its faster onset, while ropivacaine may be preferable when extended postoperative pain relief is desired.

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